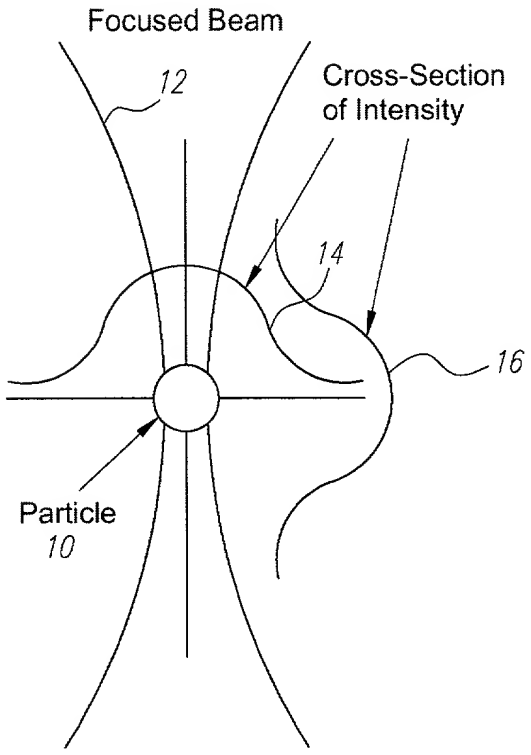


$$F_{\nabla} = 2\pi \cdot r^3 \frac{\sqrt{\varepsilon_B}}{c} \left(\frac{\varepsilon - \varepsilon_B}{\varepsilon + 2\varepsilon_B} \right) (\nabla \cdot I)$$

F_{∇} = Optical force on particle towards higher intensity

r = Radius of particle

ε_B = Dielectric constant of backround medium

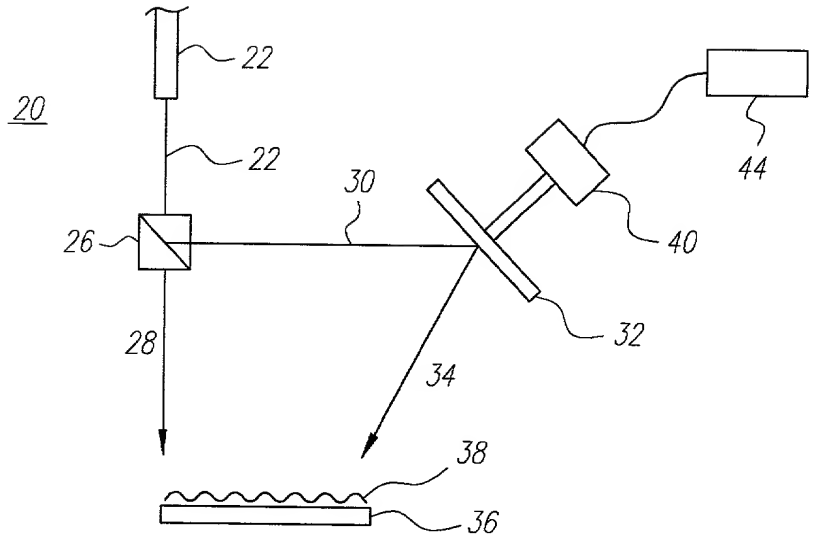
ε = Dielectric constant of particle

I = Light intensity (W/cm^2)

∇ = Spatial derivative

FIG. 1

FIG. 2



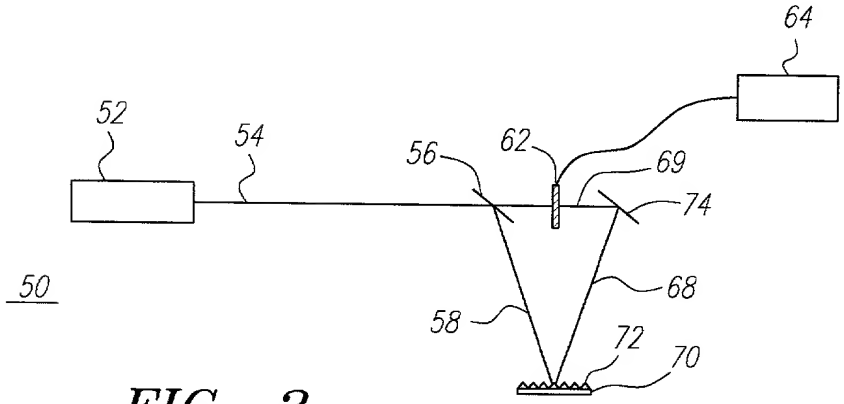


FIG. 3

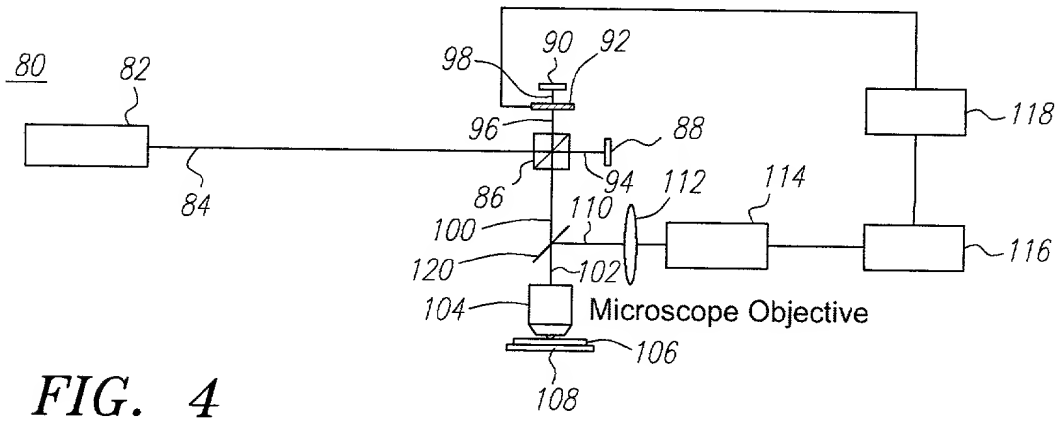


FIG. 4

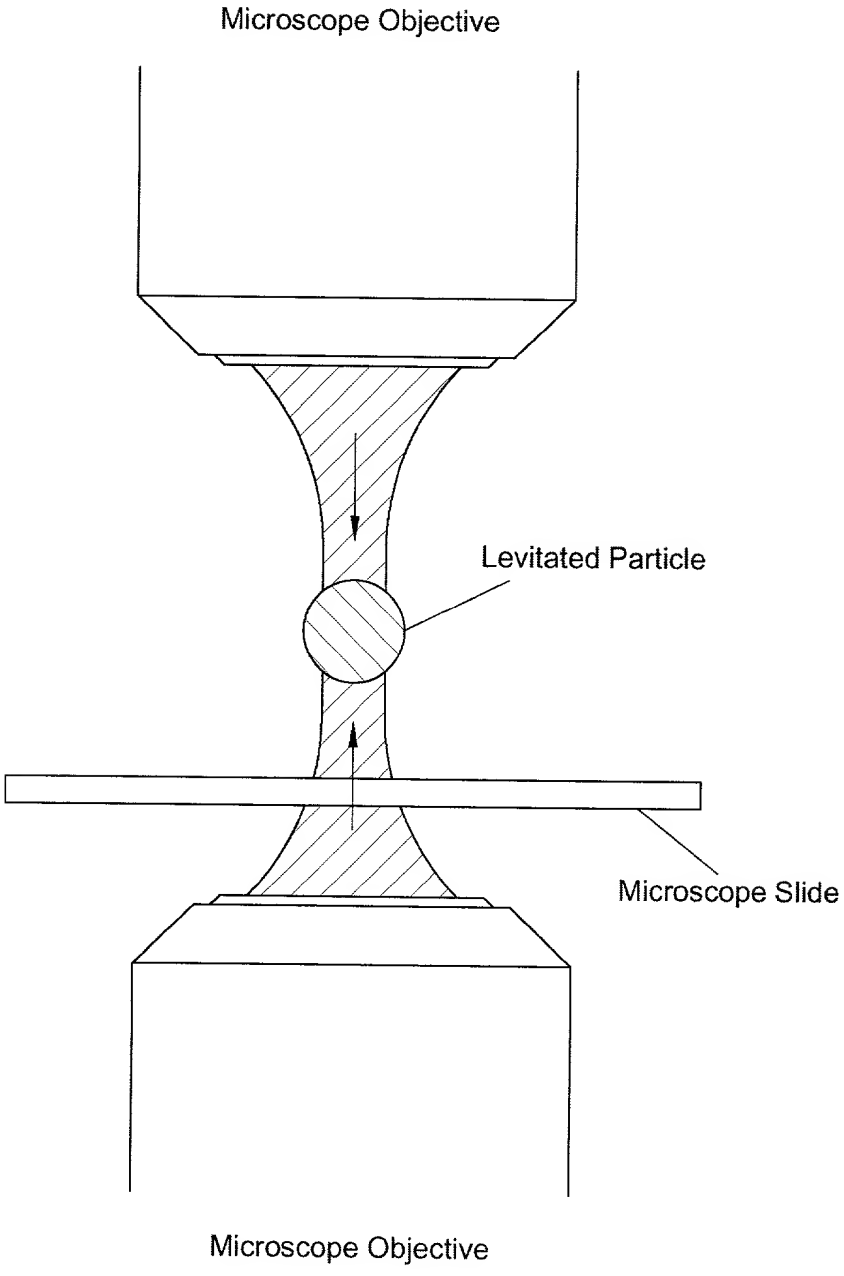

Microscope Objective
Levitated Particle
Microscope Slide
Microscope Objective

FIG. 4A

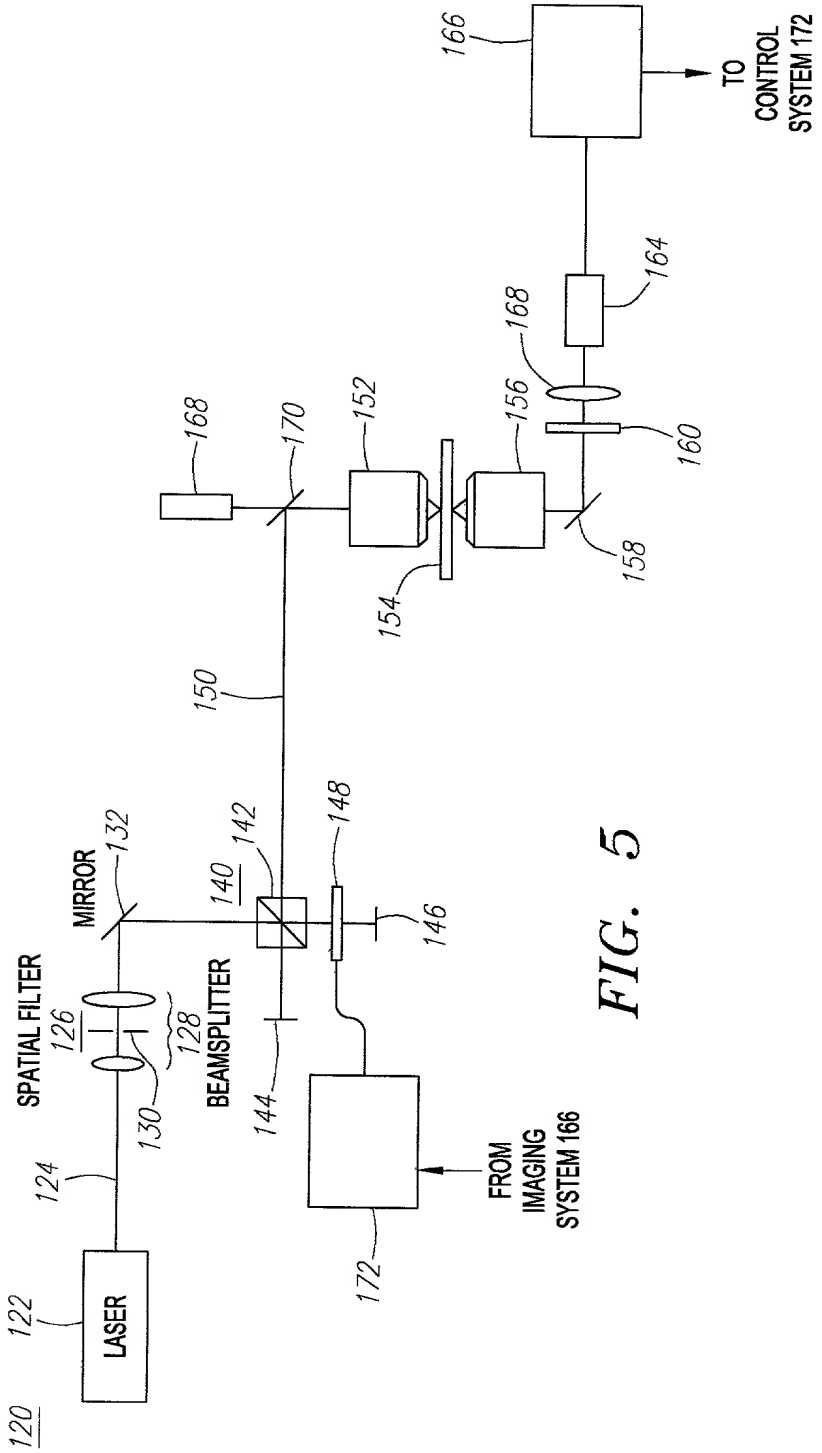

120
122
LASER
124
SPATIAL FILTER
126
128
130
MIRROR
132
140
142
BEAMSPLITTER
144
146
148
150
152
154
156
158
160
164
166
168
170
172
FROM IMAGING SYSTEM 166
TO CONTROL SYSTEM 172

FIG. 5

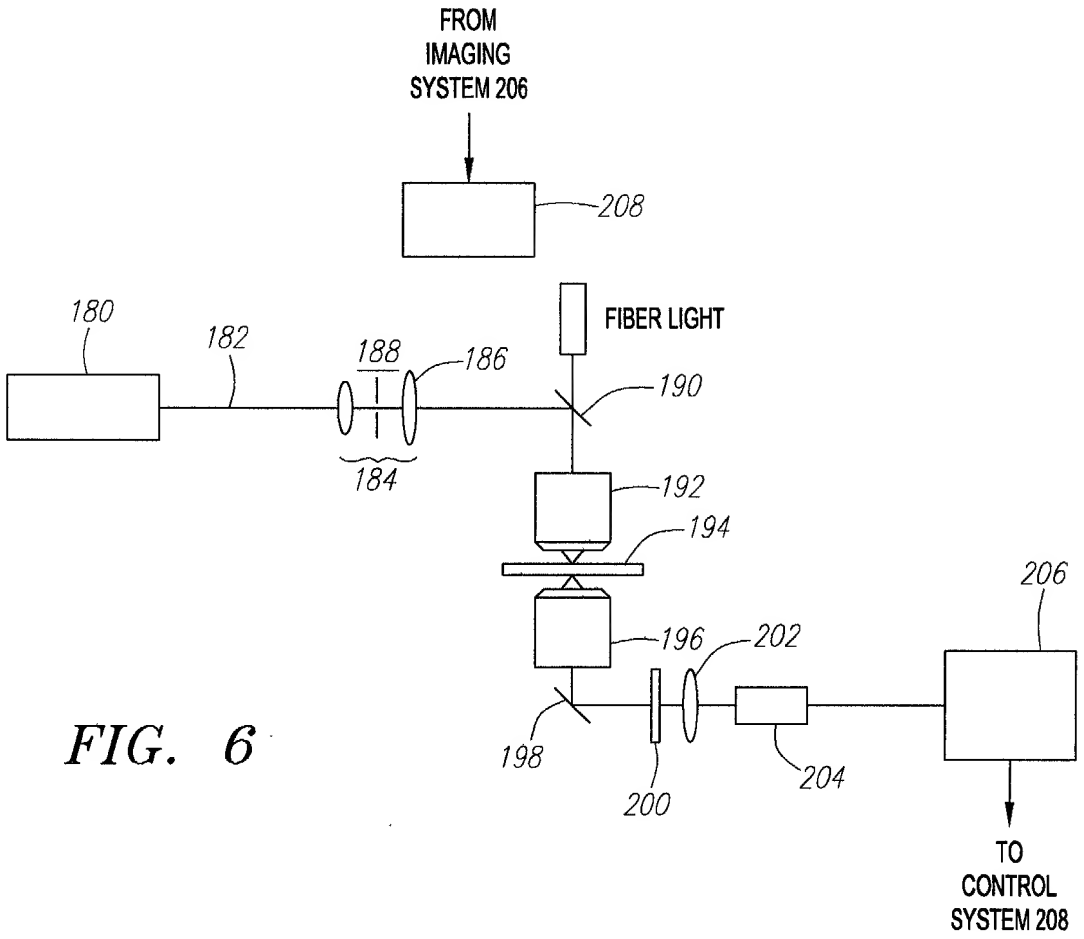

FROM
IMAGING
SYSTEM 206
208
180
182
188
186
FIBER LIGHT
190
184
192
194
206
196
202
198
200
204
TO
CONTROL
SYSTEM 208

FIG. 6

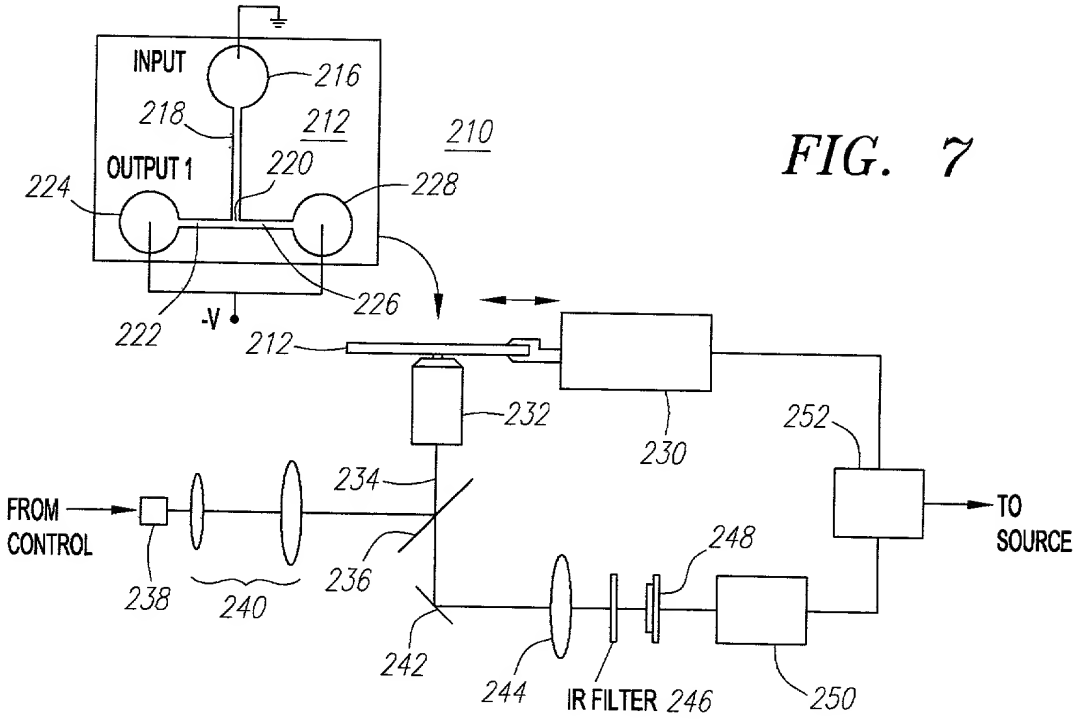

INPUT
216
218
212
210
OUTPUT 1
220
224
228
226
222
-V
212
232
230
252
234
FROM CONTROL
TO SOURCE
238
240
236
248
242
244
IR FILTER 246
250

FIG. 7

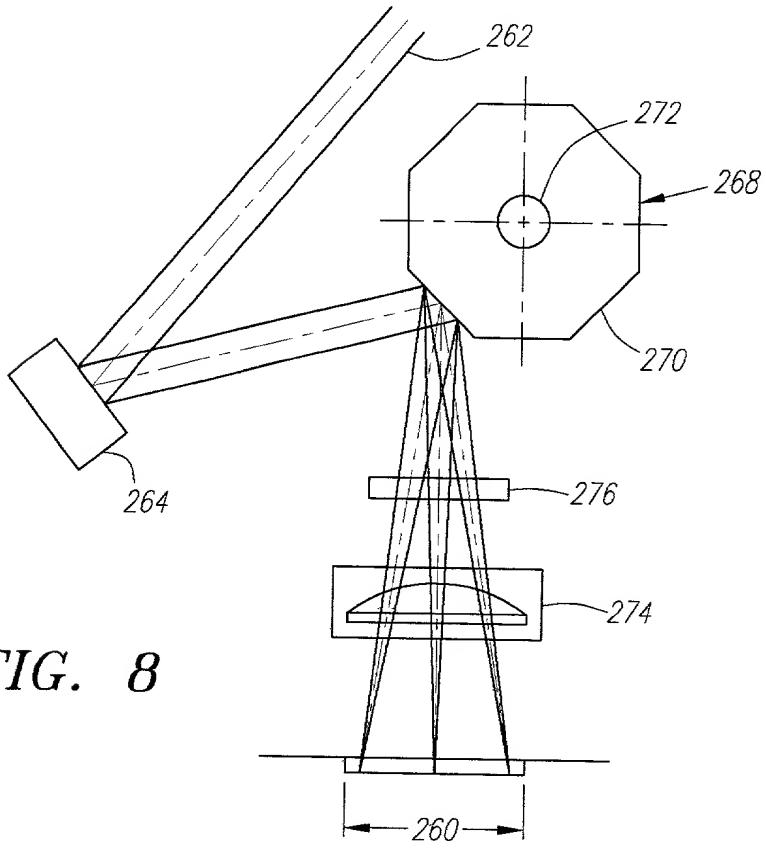

262
272
268
270
264
276
274
260

FIG. 8

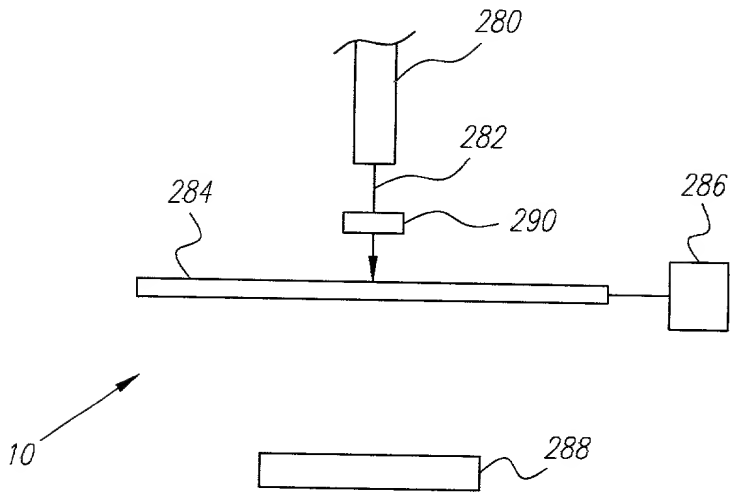


FIG. 9A

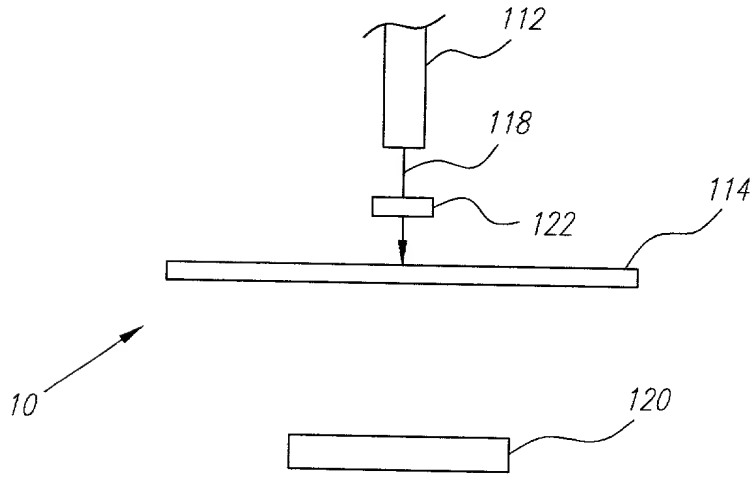


FIG. 9B

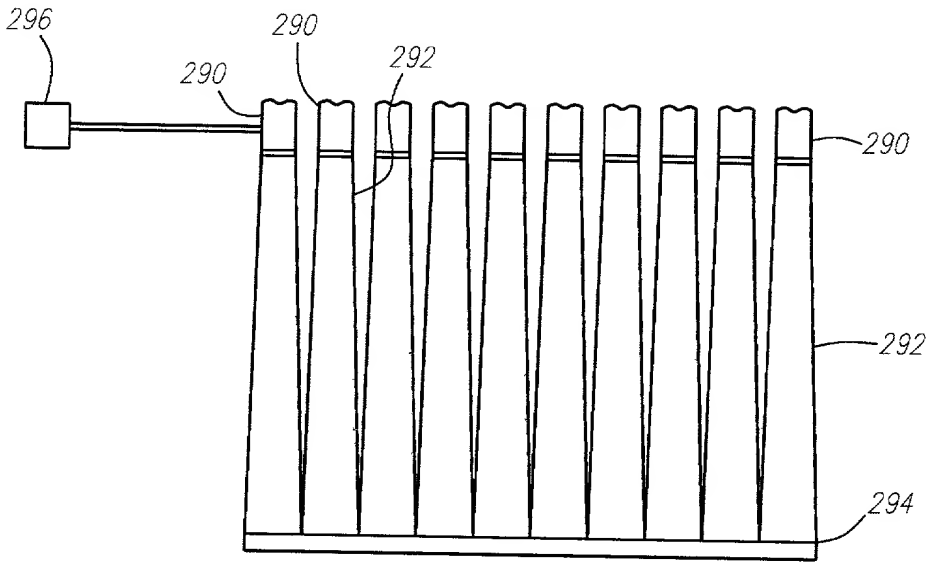


FIG. 10

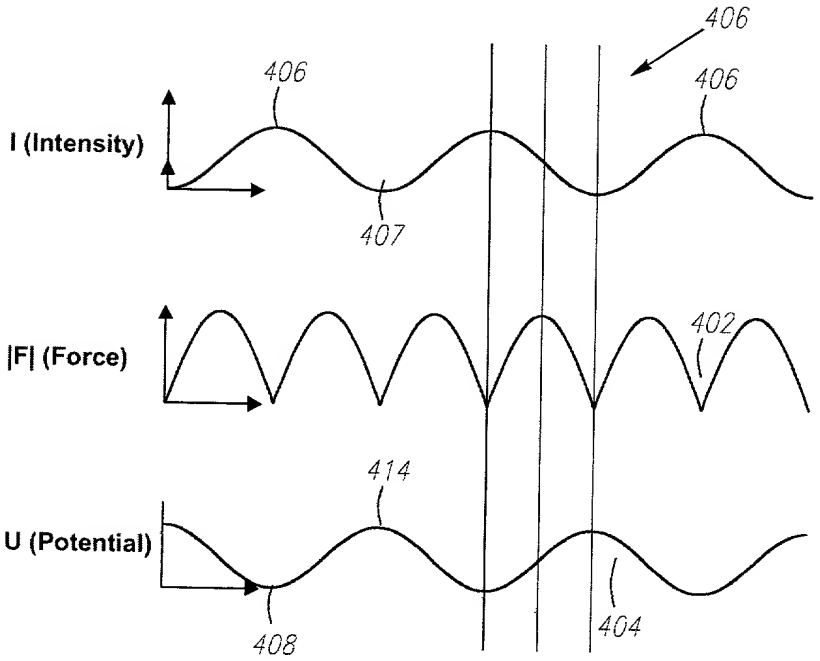


FIG. 11A

FIG. 11B

FIG. 11C

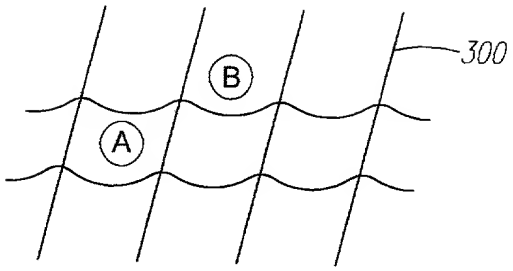


FIG. 12A

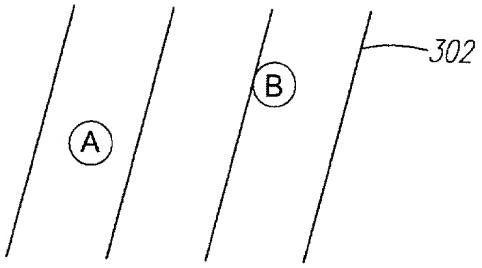


FIG. 12B

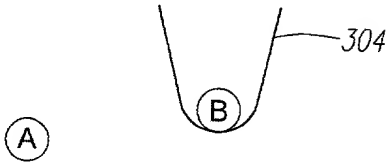


FIG. 12C

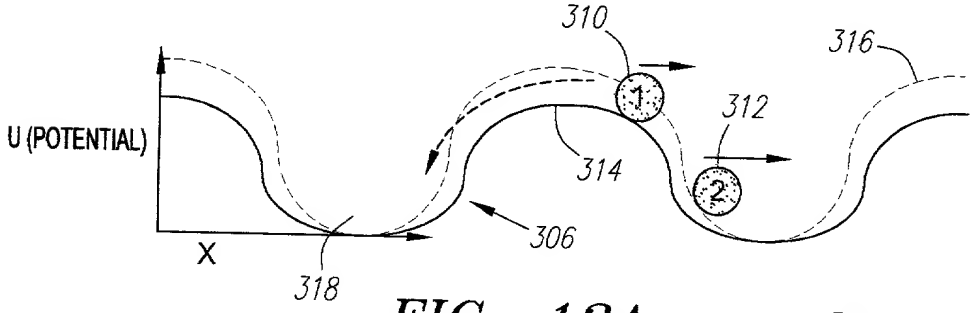


FIG. 13A

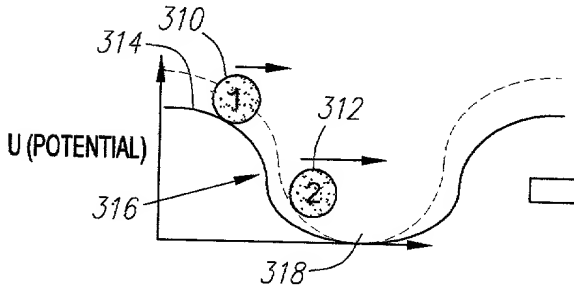


FIG. 13B

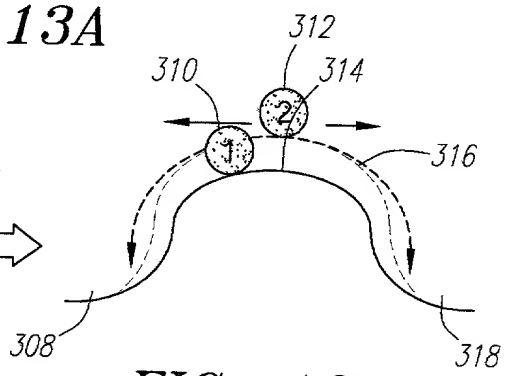


FIG. 13C

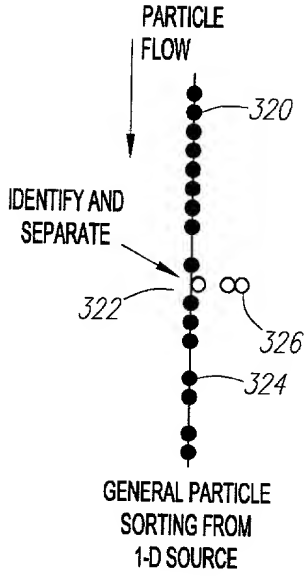


FIG. 14A

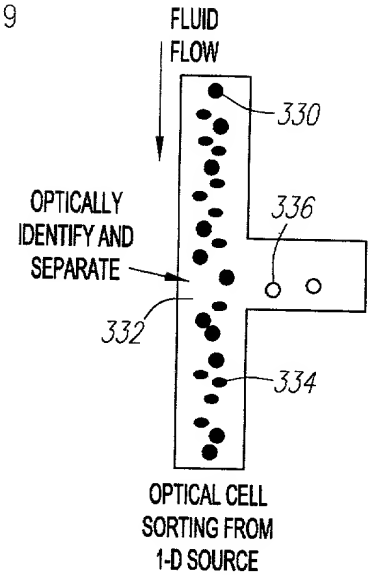


FIG. 14B

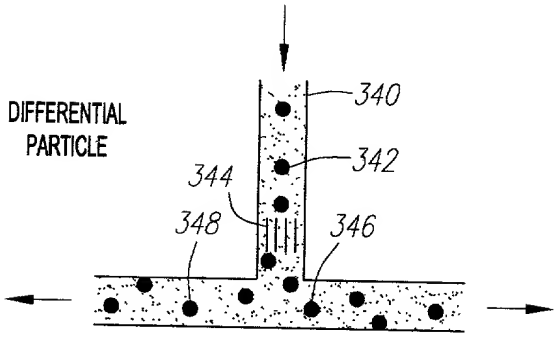


FIG. 15

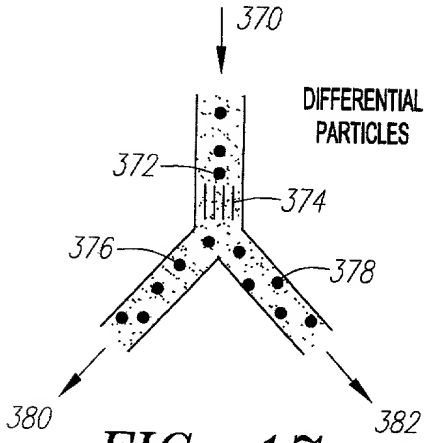


FIG. 17

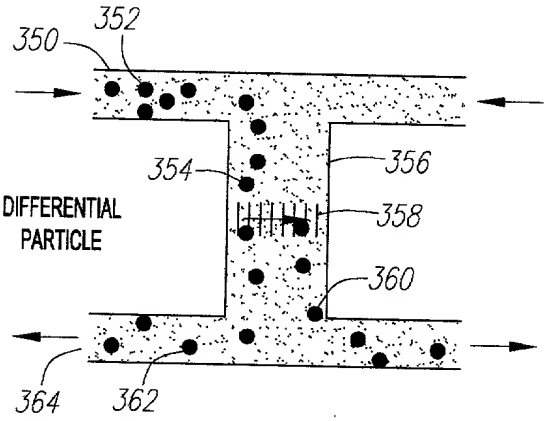


FIG. 16

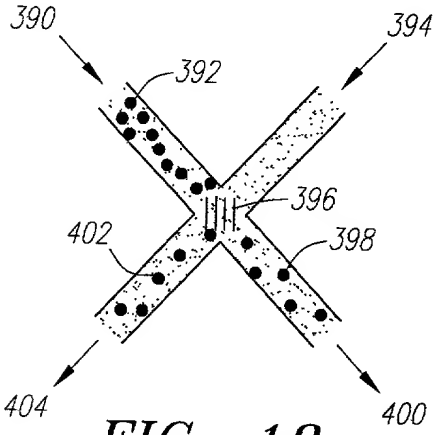


FIG. 18

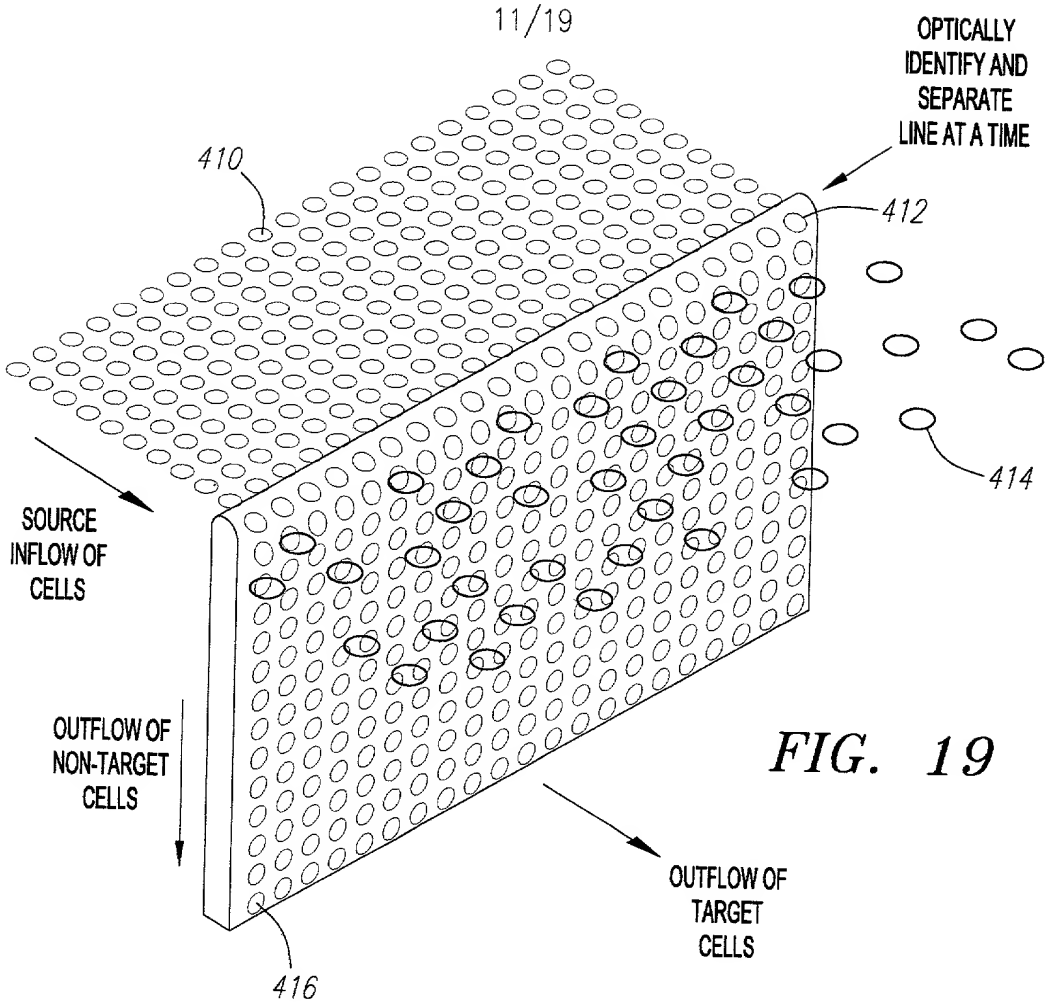


FIG. 19

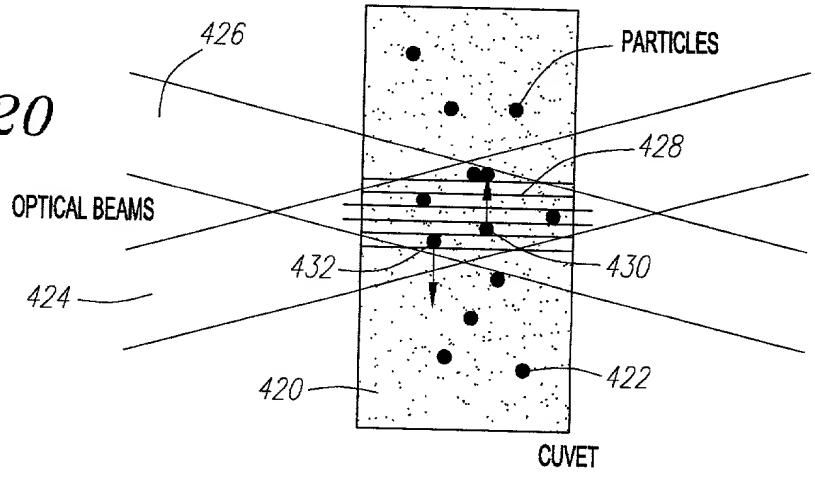


FIG. 20

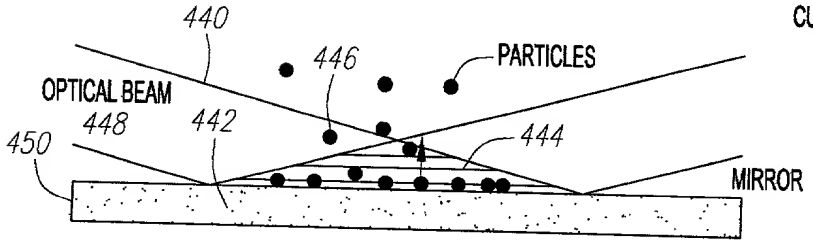


FIG. 21

09/963,848 - 2004-04-06

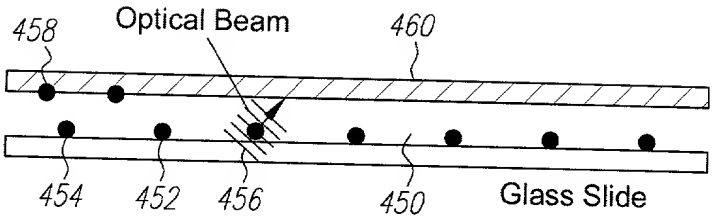
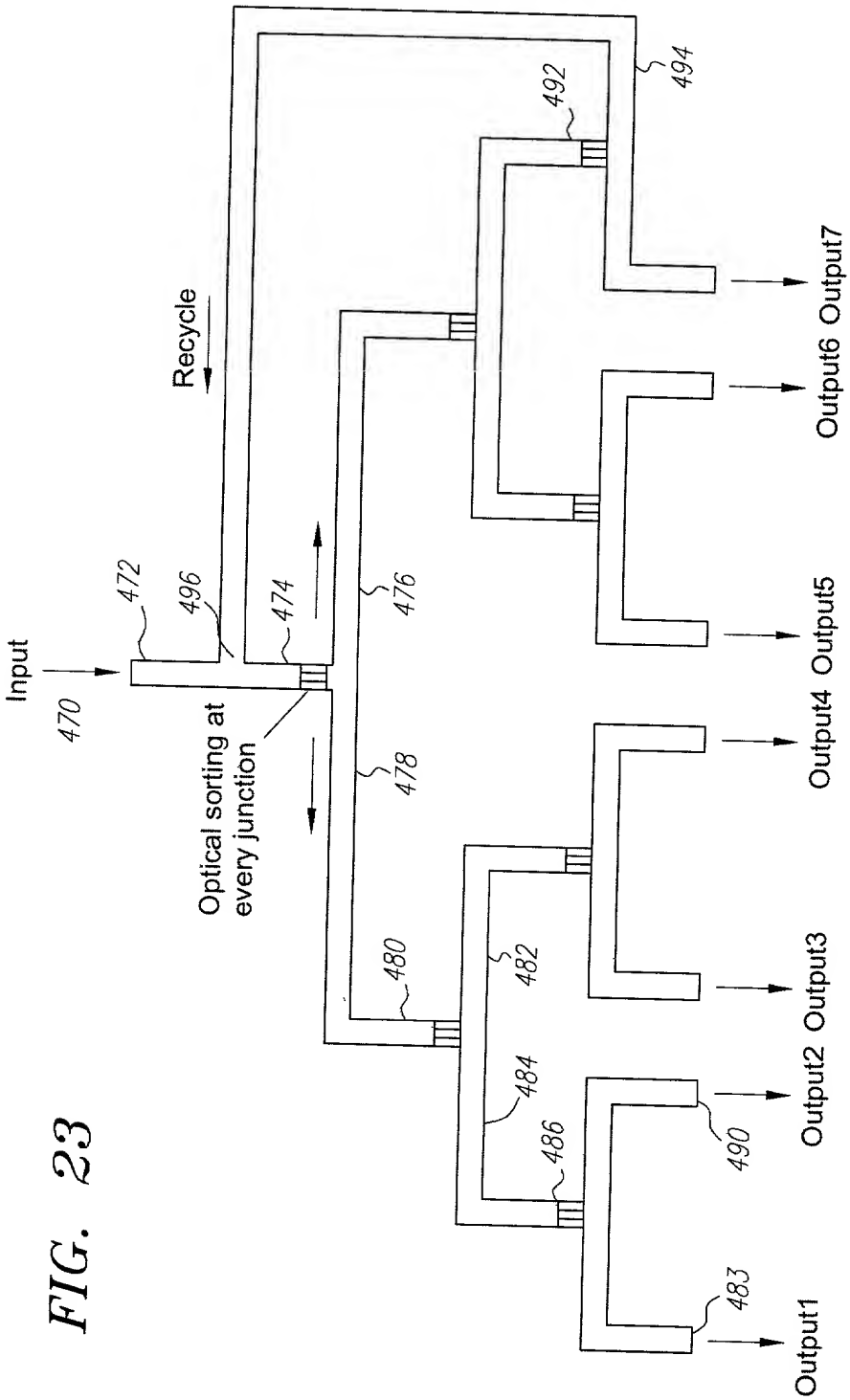


FIG. 22

Entered: 05/25/2010

FIG. 23



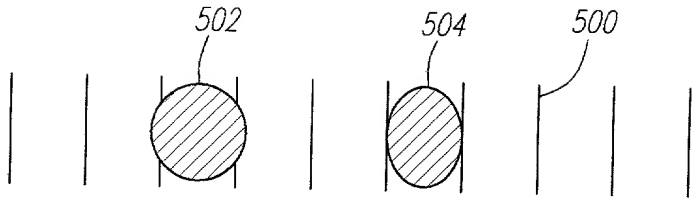


FIG. 24

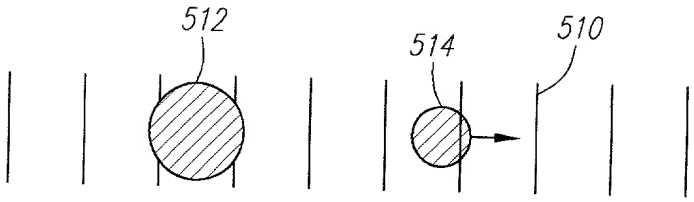
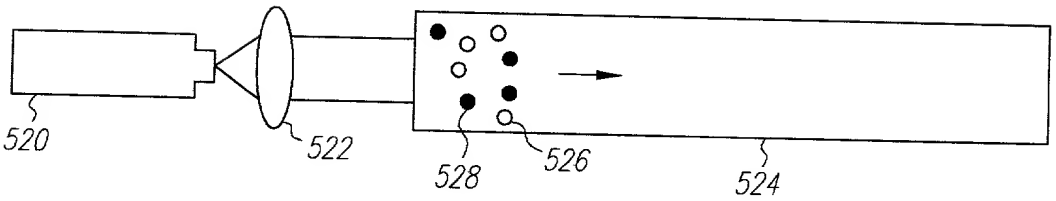


FIG. 25

Before: SCATTER FORCE SEPARATION



After:

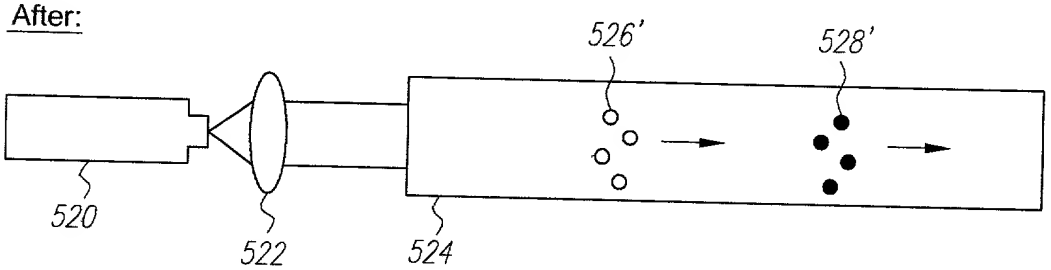


FIG. 26

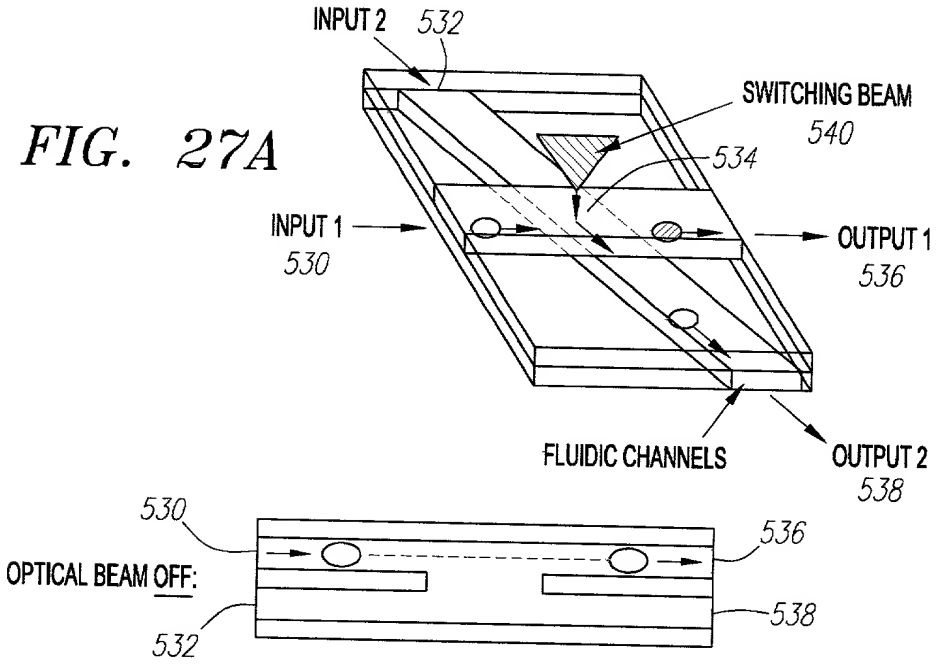


FIG. 27A

FIG. 27B

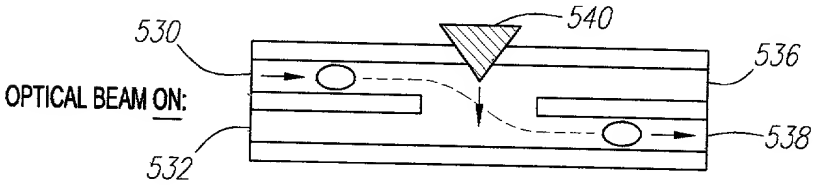


FIG. 27C

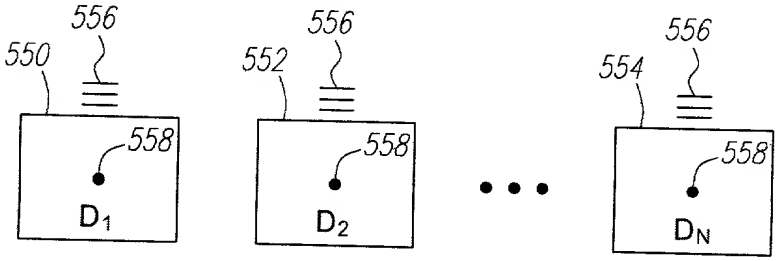


FIG. 28

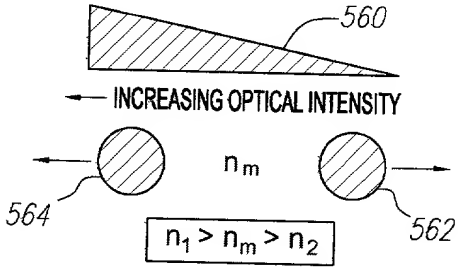


FIG. 29

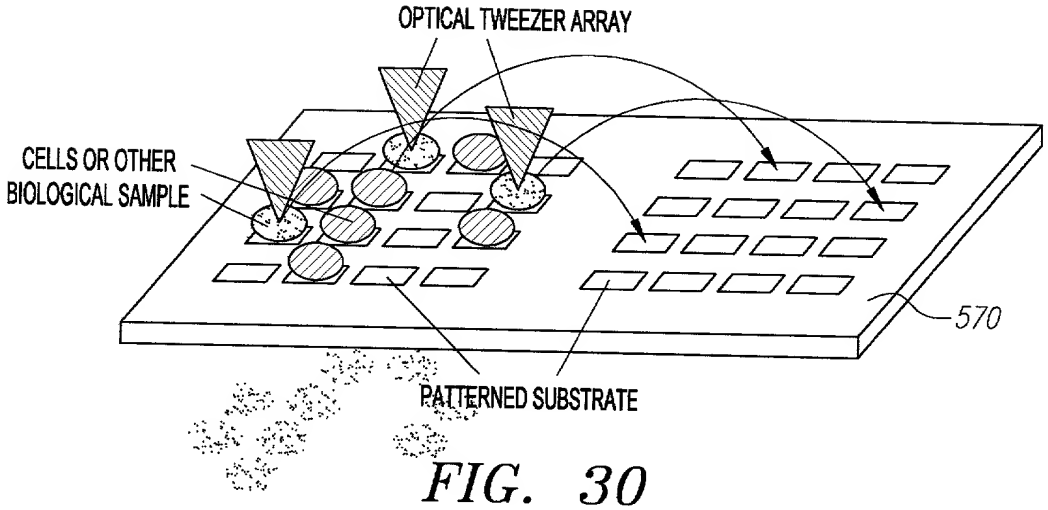

OPTICAL TWEEZER ARRAY
CELLS OR OTHER
BIOLOGICAL SAMPLE
570
PATTERNED SUBSTRATE

FIG. 30

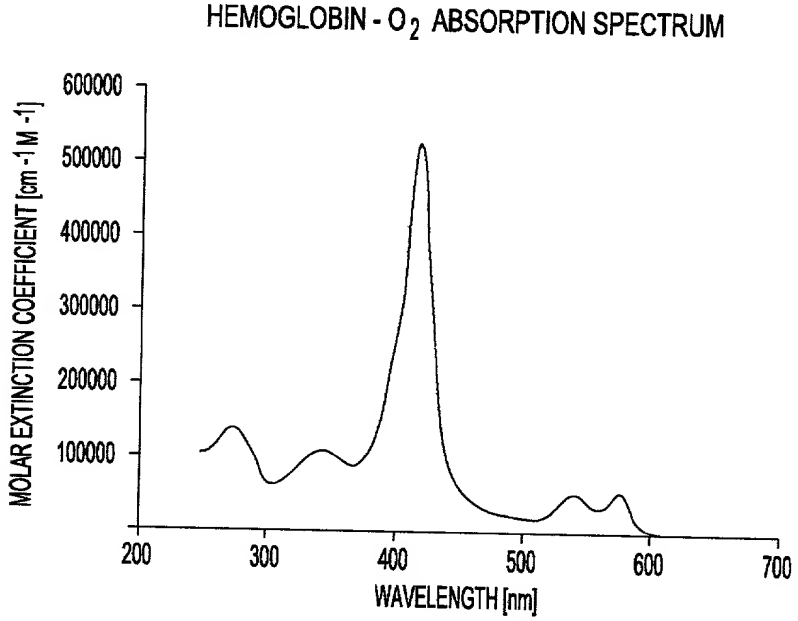

HEMOGLOBIN - O_2 ABSORPTION SPECTRUM
MOLAR EXTINCTION COEFFICIENT [cm -1 M -1]
600000
500000
400000
300000
200000
100000
200
300
400
500
600
700
WAVELENGTH [nm]

FIG. 31

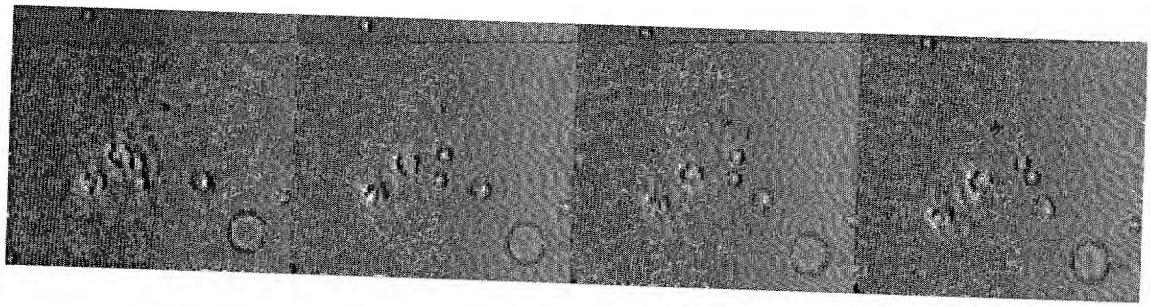


FIG. 32

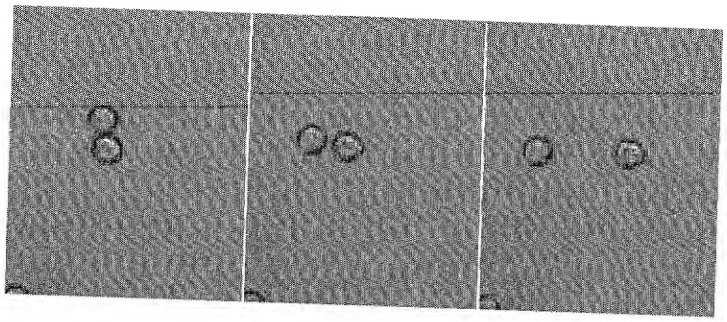


FIG. 33

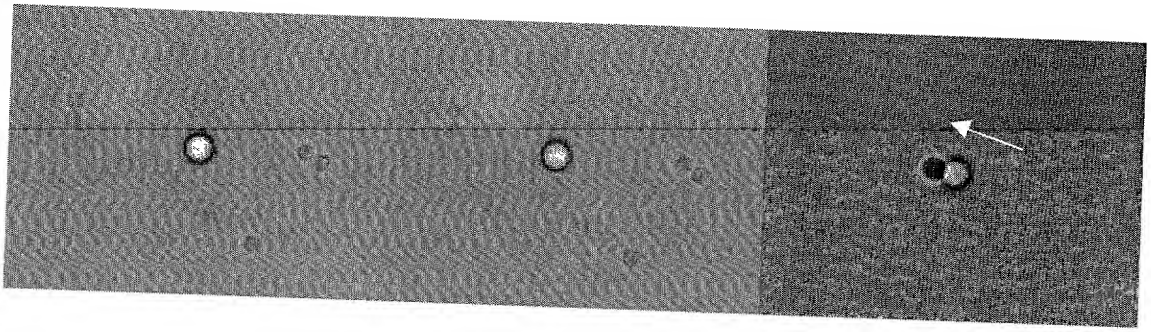


FIG. 34

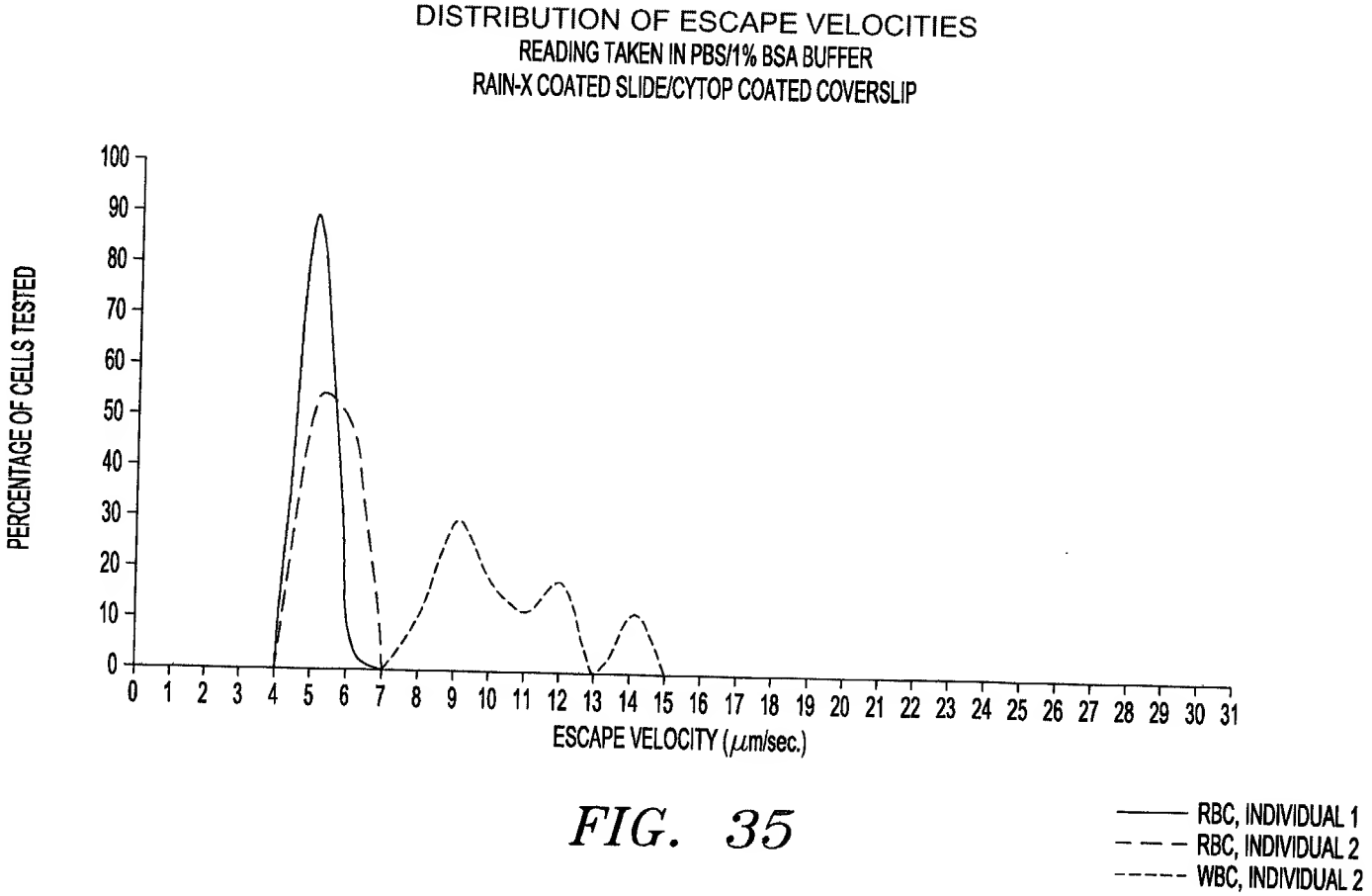

DISTRIBUTION OF ESCAPE VELOCITIES
READING TAKEN IN PBS/1% BSA BUFFER
RAIN-X COATED SLIDE/CYTOP COATED COVERSLIP
PERCENTAGE OF CELLS TESTED
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
ESCAPE VELOCITY (μm/sec.)
RBC, INDIVIDUAL 1
RBC, INDIVIDUAL 2
WBC, INDIVIDUAL 2

FIG. 35

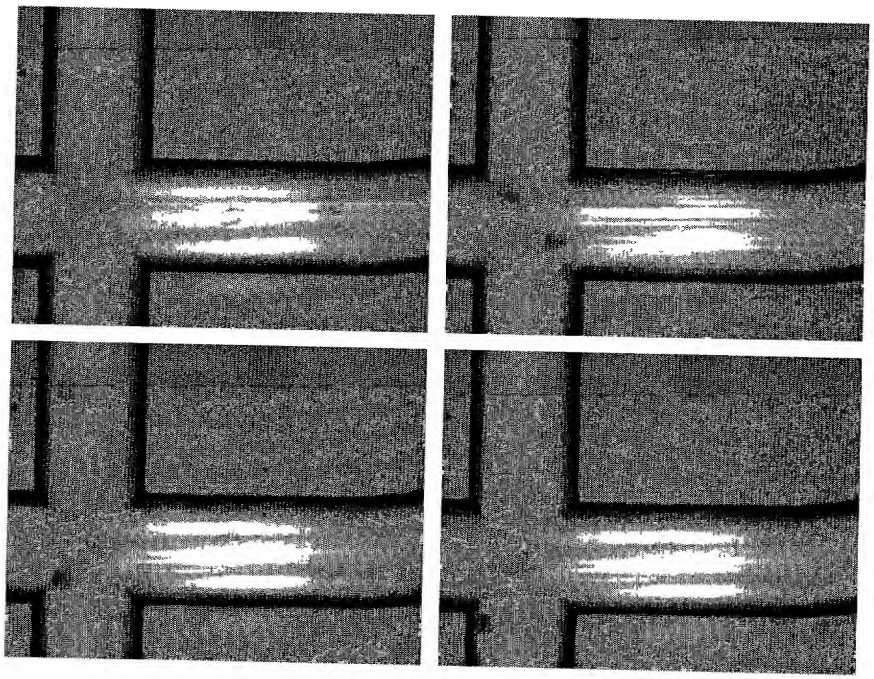


FIG. 36

2350 3 3 3